Sydney Metro Network Stage 2

Reference Design

Section 19 - Platform Screen Doors

Platform Screen Doors Reference Design Report

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1 Purpose of Report

1.1 Purpose

The purpose of this report is to:

- Confirm the key functions of the PSD system;
- Confirm the key reference design criteria;
- Confirm the key design decisions taken during the development of the reference design;
- Confirm the key PSD interfaces;
- Confirm the key client decisions which have influenced the PSD design;
- Confirm design options considered during the reference design;
- Identify the key safety factors arising from the introduction of PSDs;
- Identify key factors arising from inclusion of PSDs;
- Confirm the key standards which govern the PSD design.

1.2 Definitions and Abbreviations

DCU	Door Control Unit
DOI	Door Open Indicator
DOS	Door out of Service (indicator)
EED	Emergency exit door
CSER	Communication and Signalling Room
IMO	Infrastructure Maintenance Operator
PED	Platform End Door
PSD	Platform Screen Door
PSTC	Power Station Tunnel Control
Short Train	A train consist, which is less than the ultimate of 6 cars.

2 Standards / Guidelines

2.1 Design Standards

A set of design standards pertinent to the design of Platform Screen doors are included in Appendix A.

Figure 2.1 Typical PSD Installation

3 Key Design Issues

3.1 Purpose of the PSD Installation

The PSD provides the following beneficial functions

- Safety;
- Comfort;
- Lower Energy Usage;
- Maintenance / Trackway Cleanliness; and
- Aesthetics

3.2 Safety

The safety factors that arise with the inclusion of PSDs are as follows:

- Elimination of platform edge hazard falling onto track;
- A new hazard of objects / passengers getting stuck between car and PSD;
- A new hazard of objects / passengers being struck by or caught in the PSD;
- A new hazard of touch potential;
- A new hazard of obstruction of sight lines; and
- A new hazard of partial obstruction to evacuation.

3.3 Comfort

The inclusion of PSDs affects passenger comfort in the following ways:

- Eliminated / greatly reduced piston effect draughts on platforms;
- Improved consistency of air distribution (given a mechanical ventilation or air conditioned station public area);
- Improved consistency of temperature control (given a mechanical ventilation or air conditioned station public area);
- Improved station air quality (trackway dust / particulate excluded from stations);
- Improved platform acoustic conditions (PSDs provide buffer from train noise); and
- Improved cleanliness (less rubbish strewn on trackway).

3.4 Environmental Control Systems

The impact on the tunnel and station ECS are as follows:

- The inclusion of PSDs typically results in a different ECS configuration than will be the case if PSDs were not included.
- For a mechanically ventilated and/or air conditioned station, the PSDs will assist in keeping heat dissipated by trains within the tunnel and trackway areas; and
- Stations will not be piston effect ventilated.

3.5 Operations

The impact of inclusion of PSDs on train operations is as follows:

- The PSDs will be another system that will require a new set of operational procedures;
- The PSD installation will represent a future limitation on train configuration, car door sizes and locations;
- The PSD installation will limit the ability to run varying train sets on the line, however symmetrical alignment will allow different consist to operate;
- Impact of overall railway reliability – another system may lead to additional failures;
- Increased platform capacity – passenger can stand nearer the platform edge at greater densities without fear of falling onto the track; and
- Improved passenger movement and queuing resulting from greater use of the platform width.

3.6 Maintenance

The inclusion of PSDs has the following impact on maintenance:

- Less cleaning of trackway required (less rubbish, whether thrown or piston effect blown); and
- PSDs will be an additional maintenance item.

3.7 Aesthetics

PSDs will have the following impact of station aesthetics:

- In providing a constant architectural element the PSDs will have a positive visual impact; and
- The PSDs will provide opportunities to have consistent integration of signage, lighting, advertising and corporate identity.

3.8 Costs

PSDs will have the following impact on costs:

- Potential to offset PSD installation and operational cost against otherwise increased station ECS system cost and plant space requirements.

4 Reference Design Criteria

This section sets out the design criteria developed by the Engineering and Architectural Technical Advisor in response to the Product Specification requirement.

Platform Screen Doors (PSD's) will be on all Sydney Metro platforms and will have operational interface with the train doors controlled automatically by the signalling system (bi-directional signalling). There will be an allowance for the PSD's to be operated manually if faults occur.

Requirements

(a) 20 Passenger Screen Doors for 5 car train sets and 24 Passenger Screen Doors for 6 car train sets symmetrically aligned to train doors on each platform.

(b) Doors are to be full height with associated civil structures.

(c) Doors to be treated like vehicle doors in terms of passenger safety and door operation and should follow relevant standards for rail vehicle doors where applicable.

(d) Automatic Indicators on door status to be supplied.

(e) Provision of an additional 300mm in the PSD width to accommodate any variance in the stopping of the train

(f) Manual control will be provided for emergency operation of PSD's by staff

Safety Requirement and Provision

It is preferable to have the car body as close to the PSD as possible. Taper plate is provided at the moving door panel to prevent people standing in between the train door and PSD. This will also prevent the door from fully closing if an obstruction is detected.

PSD's are to be provided with obstacle detection. If a closing PSD is obstructed, the door drive system will sense the obstacle and temporarily release the closing force and will be stationary for approximately 3 seconds. This will allow the passenger to have a chance to retreat/move.

Provision of Emergency exit door

Emergency exit door panel (EED) is provided at designated locations of the PSD platform façade to allow passengers (or people from the trackside) to push it open from the trackside and leave the train. The EED is equipped with a manual push bar at mid-level of the door to provide an open action.

PSD power failure operation

There are two provisions:

(a) at trackside, a manual release handle is to be provided at each power moving door of which I being lifted; the door can be pushed open manually; and

(b) at platform side, a key switch is provided at each moving door. A special key could release the moving door lock and enable the door panel to push open manually on the platform side. (the special key should be kept by the station staff)

The following key design decisions have been established in the Product Specification volume 1 and 3:

- Inclusion of full height PSDs;
- 4 doors per car x 5 cars (the design needs to make provision to adapt from 5 car to 6 car operation without interference to train operation);
- Trackside manual release handle for each door;
- Platform side emergency control of PSDs;
- Emergency Escape Doors with trackside push bar operation;
- Platform side manually operated opening of individual doors
- Obstacle detection and
- Minimisation of space between PSD and stationary train.

4.1 PSD Structural Criteria

The structural design of the PSDs will be based on:

- A crowd loading of 3.0kN at 1.1m height;
- A piston effect pressure of 3.26kPa (110kph) towards the platform and 1.38kPa (85kph) towards the track;
- An impact loading of 140Nsec applied as a half sine wave of amplitude 2.8kN applied for 0.08sec over a 100mm x 100mm area;
- Seismic design criteria; and
- High level structural support.

4.2 Environmental Criteria

The PSD design will be based on the following environmental criteria:

4.2.1 Thermal

The station public area environmental control system does not require platform screen doors to be double glazed from a thermal comfort perspective.

4.2.2 Acoustics

The noise levels at 1m from the platform edge on any platform resulting from operation of the PSDs will not exceed the following criteria with either PSDs movement alone or train and PSD doors combined.

- Target 70dB(A) fast response; and

• Acceptance	73 dB (A) fast response.

The noise levels within a train at 1m from the train door opening resulting from operation of the PSDs will not exceed:

• Target	73 dB(A) fast response; and
• Acceptance	76 dB (A) fast response.

4.2.3 Vibration

The limiting criteria for vibration generation will be specified by range classification for Class 1 applications as defined in BS 7854 ‘Mechanical Vibration – Evaluation of Machine Vibration by Measurements on non-rotating Parts’.

These figures will be tested on the basis of an empty train with all PSDs operating and train doors open.

4.2.4 Air Permeability

The PSD installation along the platform edge should be designed to meet the air permeability requirement of Class 1 Classification of BS EN12207: ‘windows and doors – Air Permeability – Classification in Limiting the Total Infiltration and Exfiltration’.

4.2.5 Non - Stopping Train going through the Station

The PSD structural design will be able to withstand the pressure created by a service train passing the station at the maximum operational speed allowed at that section of track.

4.3 Architectural Criteria

4.3.1 PSD Equipment Spatial Allowance

PSD equipment will mostly be located in the header boxes. A control electronic rack will be located in the adjacent Platform Communications and Signalling Room (CSER).

4.3.2 Glazing

Panels will be made of 8mm toughened glass.

4.3.3 PSD Framing

Framing will be kept to a minimum in order to improve visibility and sightlines. Framing will be anodised aluminium or stainless steel. Threshold plates will be stainless steel.

4.3.4 Graffiti

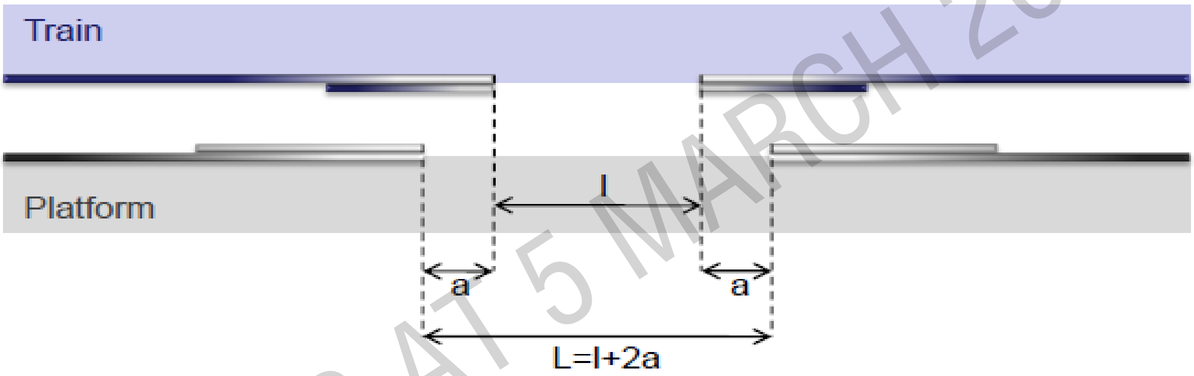
The design of the PSD will minimise the ability of graffiti to be applied to its surfaces, will be resistant to physical abuse and mechanical damage. The PSD will facilitate ease of removing graffiti, and replacement/repair of all components exposed to graffiti, physical abuse and mechanical damage.

4.4 PSD Configuration

4.4.1 Sliding Screen Door Opening Width

The train door clear opening width is 1400mm. Allowing for a train stopping accuracy of +/- 300mm, (variance with Performance spec to be reviewed in 100%) this means that the clear opening width of a pair of sliding screen doors will 2000m.

Figure 4.1 Door Width



4.4.2 Emergency Escape Doors

The space in between the sliding screen doors will be equipped with hinged Emergency Escape Doors (EED) equipped with push bars at waist height on the trackside to facilitate escape by passengers in the event of a misaligned train.

4.4.3 Door Opening Height

Door opening height will be 2150mm clear for all openable panels (PSD, EED and PED).

4.5 PSD Control

4.5.1 Sliding Screen Door Opening / Closing

The time taken to open the PSD will be 2.5 to 3.0 seconds. The time taken to close the PSD will be 3.0 to 3.5 seconds. The maximum velocity for PSD closing will be 0.5m/s.

4.5.2 Sliding Screen Door Synchronisation

A maximum synchronisation time difference of 0.5 seconds between PSD and the train door will be achieved.

4.5.3 Sliding Screen Door Harmonisation

The operation of PSD will be harmonised with the train doors such that in the event that a platform screen door set has been isolated, the corresponding train doors will be prevented from opening. Similarly, if a train door set has been isolated, the corresponding platform screen door set will be prevented from opening.

The PSD interface with the train will be via the signaling and train control system.

4.5.4 Sliding Screen Door Closing Force

The target maximum will be 133N per leaf with an absolute maximum closing force of 150N per leaf.

4.5.5 Sliding Screen Door Movement Kinetic Energy

The maximum door leaf kinetic energy will not exceed 10 Joules while the door movement kinetic energy for the last 100mm of leaf travel will be less than 1 Joule per leaf.

4.5.6 Power Station Tunnel Control (PSTC) Interface

PSD should provide the ability for the PSTC, to monitor the operation of the platform screen doors including:

- Power supply feeder status;
- Fault conditions together with the identification of the specific doors to which they apply;
- Number of operations;
- Safety loop breaches together with the identification of the specific doors to which they apply; and
- Any other parameters necessary to maintain and operate the platform screen doors.

The PSD will enable the PSTC to provide “group status” indication for each set of PSD to the signalling system for incorporation into the signalling displays. The “group status” will show the combined status of all PSDs in one PSD line, these being open, closed and faulty.

The PSD will provide to the changes to equipment status, events, alarm signals to allow the PSTC system to compile reports of PSD availability.

4.6 PSD Operation

PSDs will have the following modes of operation:

- Normal;
- Degraded;
- Emergency; and
- Isolated / Maintenance (Individual sliding screen door Sets)

4.6.1 Normal Operation

Operation of the PSDs in normal mode is shown in the diagram below.

(Example of Typical Logic Only)

Figure 4.2 Normal Opening Sequence

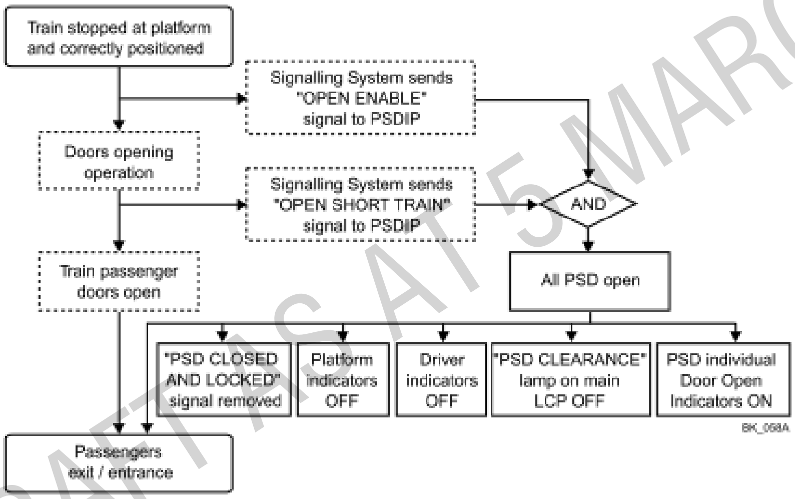
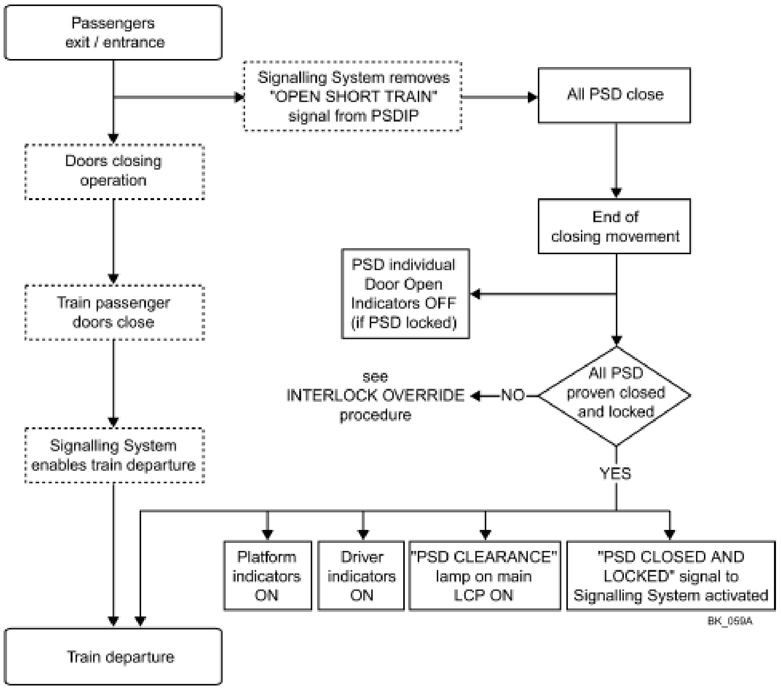

Train stopped at platform and correctly positioned
Signalling System sends "OPEN ENABLE" signal to PSDIP
Doors opening operation
Signalling System sends "OPEN SHORT TRAIN" signal to PSDIP
AND
Train passenger doors open
All PSD open
"PSD CLOSED AND LOCKED" signal removed
Platform indicators OFF
Driver indicators OFF
"PSD CLEARANCE" lamp on main LCP OFF
PSD individual Door Open Indicators ON
BK_068A
Passengers exit / entrance

Figure 4.3 Normal Closing Sequence

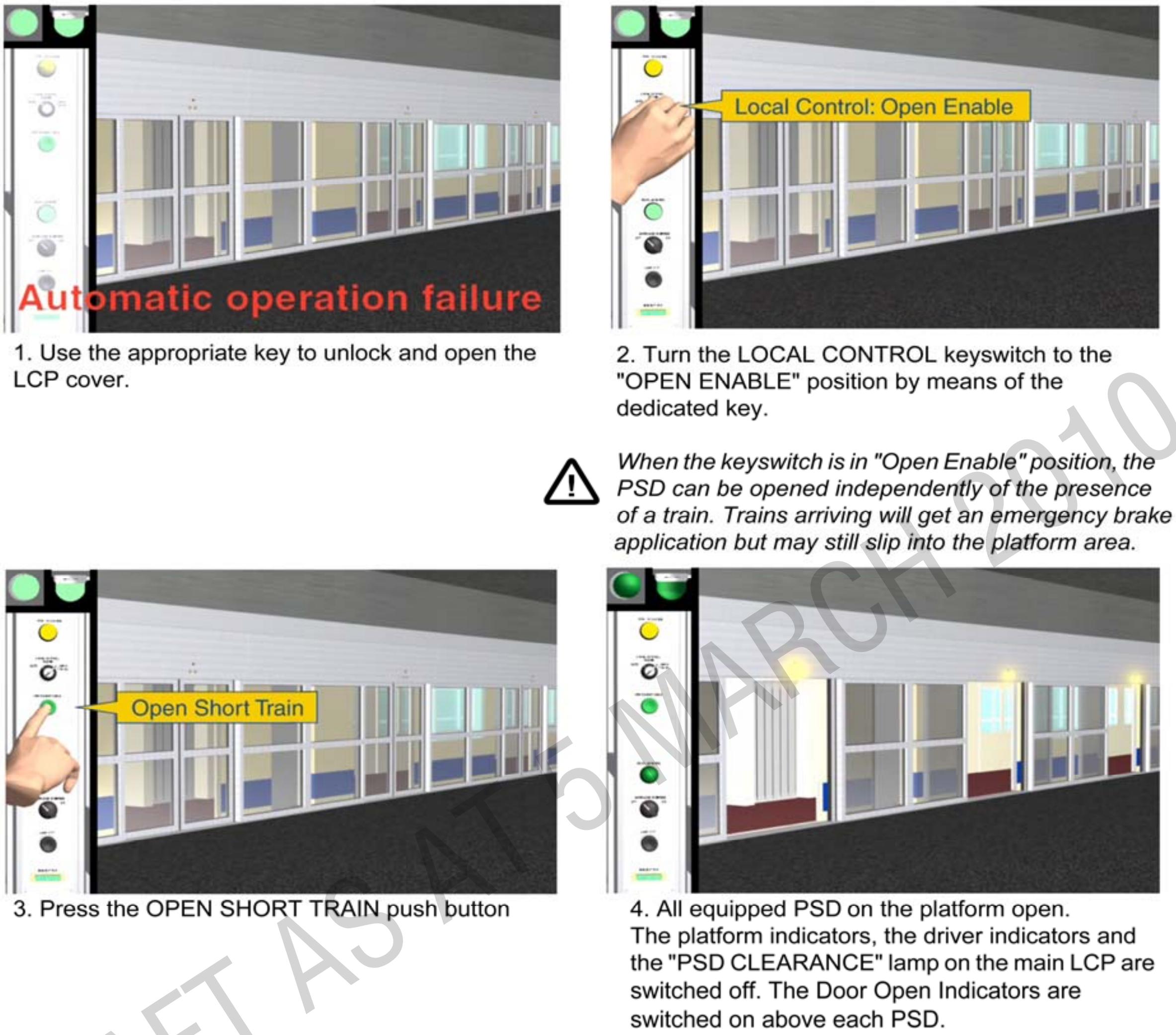

Passengers exit / entrance
Signalling System removes "OPEN SHORT TRAIN" signal from PSDIP
All PSD close
Doors closing operation
End of closing movement
PSD individual Door Open Indicators OFF (if PSD locked)
Train passenger doors close
see INTERLOCK OVERRIDE procedure
NO
All PSD proven closed and locked
Signalling System enables train departure
YES
Platform indicators ON
Driver indicators ON
"PSD CLEARANCE" lamp on main LCP ON
"PSD CLOSED AND LOCKED" signal to Signalling System activated
BK_059A
Train departure

4.6.2 Degraded Mode

In case of obstacle detection, the door will consecutively try to close three times (adjustable). If after closing for the default number of times the door is still open then the PSD will go into failure mode.

- In case of an incoming signal failure, the façade can be manually operated from the Local Control Panel (located at the door panel).

Figure 4.4 Degraded Mode



1. Use the appropriate key to unlock and open the LCP cover.

2. Turn the LOCAL CONTROL keyswitch to the "OPEN ENABLE" position by means of the dedicated key.

⚠ *When the keyswitch is in "Open Enable" position, the PSD can be opened independently of the presence of a train. Trains arriving will get an emergency brake application but may still slip into the platform area.*

3. Press the OPEN SHORT TRAIN push button

4. All equipped PSD on the platform open. The platform indicators, the driver indicators and the "PSD CLEARANCE" lamp on the main LCP are switched off. The Door Open Indicators are switched on above each PSD.

- In case of a door safety loop failure, an interlock override signal is sent (under attendance by platform staff) to the signalling from the LCP to force the departure of the train.
- In case of a PSD failure, the individual PSD is put in isolated mode.

4.6.3 Emergency Mode

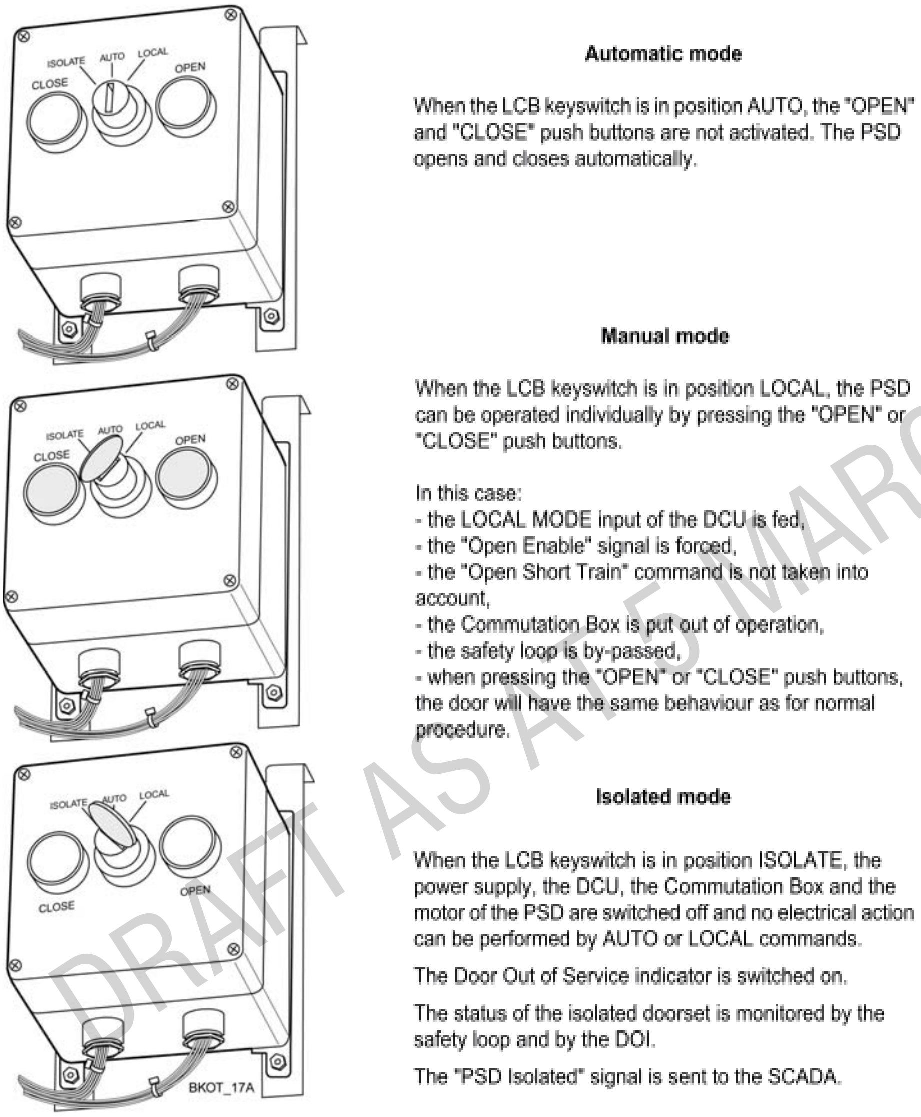
The following features are included:

- Emergency Escape Doors (EEDs); and
- Individual Manual Operation of each PSD.

4.6.4 Isolated Mode

A switch box will be required to enable individual door isolation for maintenance or locking out of service following a failure.

Figure 4.5 Local Control Box



Automatic mode

When the LCB keyswitch is in position AUTO, the "OPEN" and "CLOSE" push buttons are not activated. The PSD opens and closes automatically.

Manual mode

When the LCB keyswitch is in position LOCAL, the PSD can be operated individually by pressing the "OPEN" or "CLOSE" push buttons.

In this case:
- the LOCAL MODE input of the DCU is fed,
- the "Open Enable" signal is forced,
- the "Open Short Train" command is not taken into account,
- the Commutation Box is put out of operation,
- the safety loop is by-passed,
- when pressing the "OPEN" or "CLOSE" push buttons, the door will have the same behaviour as for normal procedure.

Isolated mode

When the LCB keyswitch is in position ISOLATE, the power supply, the DCU, the Commutation Box and the motor of the PSD are switched off and no electrical action can be performed by AUTO or LOCAL commands.

The Door Out of Service indicator is switched on.

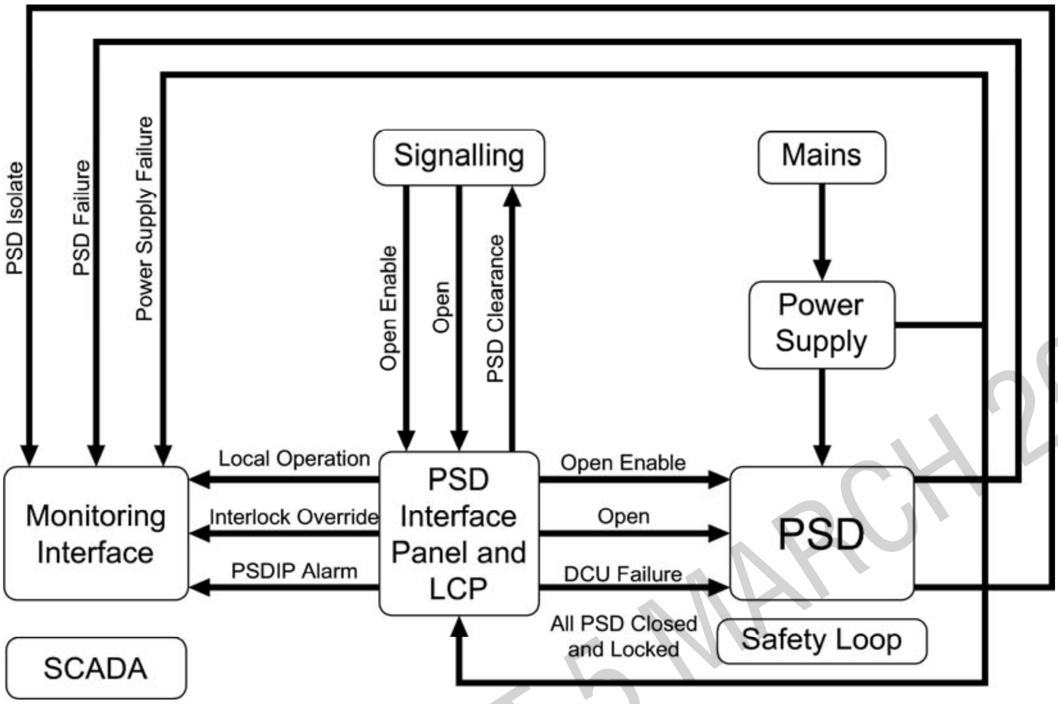
The status of the isolated doorset is monitored by the safety loop and by the DOI.

The "PSD Isolated" signal is sent to the SCADA.

4.6.5 Control Interfaces

A schematic showing the control interfaces is shown below.

Figure 4.6 PSD Interfaces

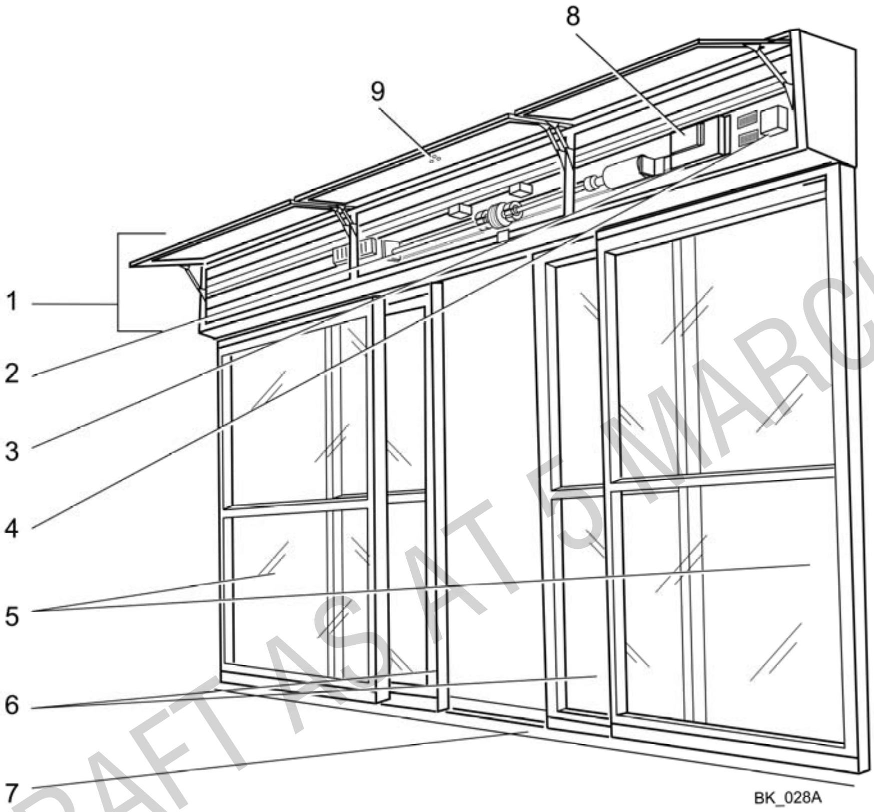


4.7 PSD Elements

4.7.1 Sliding Screen Doors

The automatic sliding screen doors form the main opening to allow access between the platform and the train.

Figure 4.7 Sliding Screen Doors



1	Header Box	2	Door operator	3	DCU
4	Local Control Box	5	Fixed Panels	6	PSD Leaves
7	Threshold	8	Commutation Box	9	DOI and DOS LED

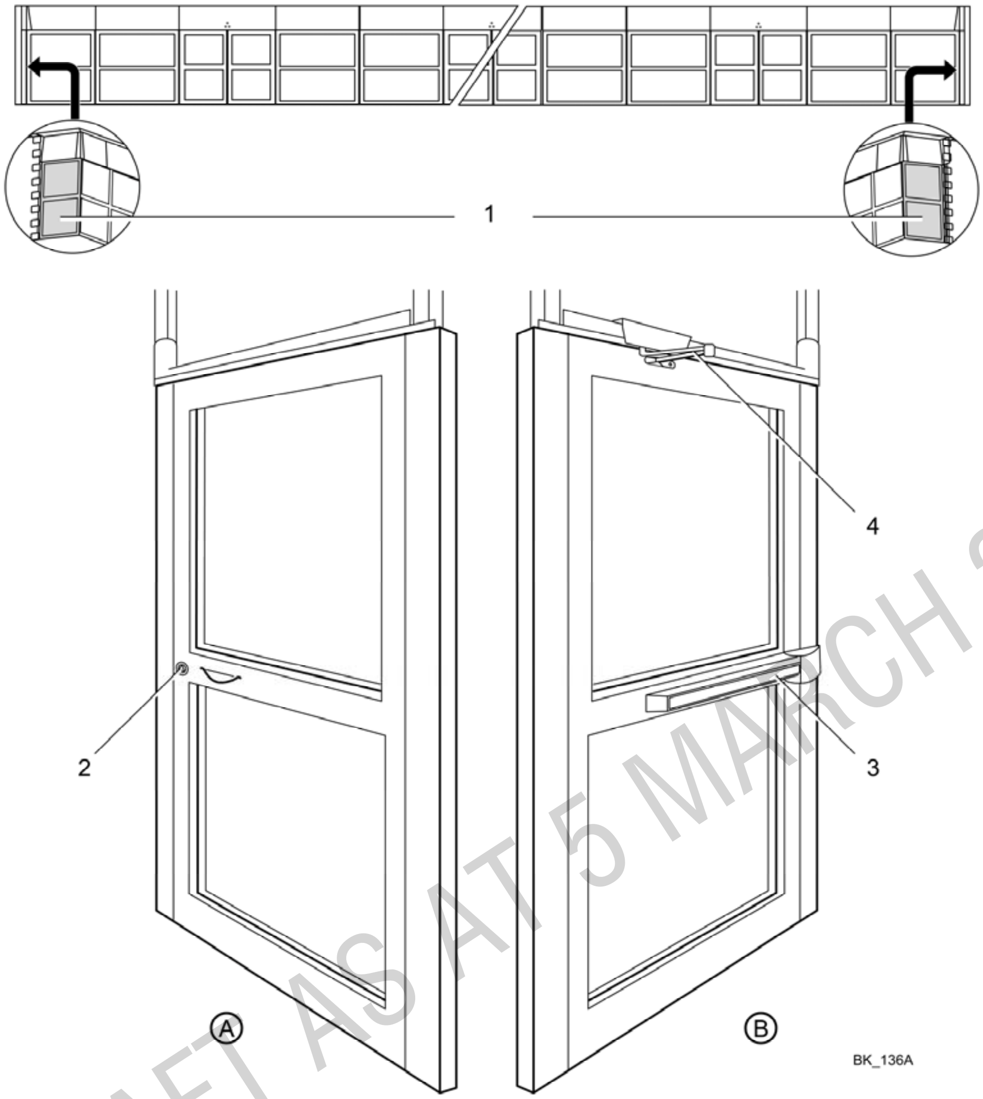
4.7.2 Emergency Escape Doors

Emergency escape doors will be provided in between the sliding screen doors. These will be hinged and have an opening push bar located on the track side to facilitate escape by passengers in the event of a train misaligning.

4.7.3 Platform End Door

The proposed configurations of access beyond the ends of the platforms are such that Platform End Doors do not form part of the Reference Design.

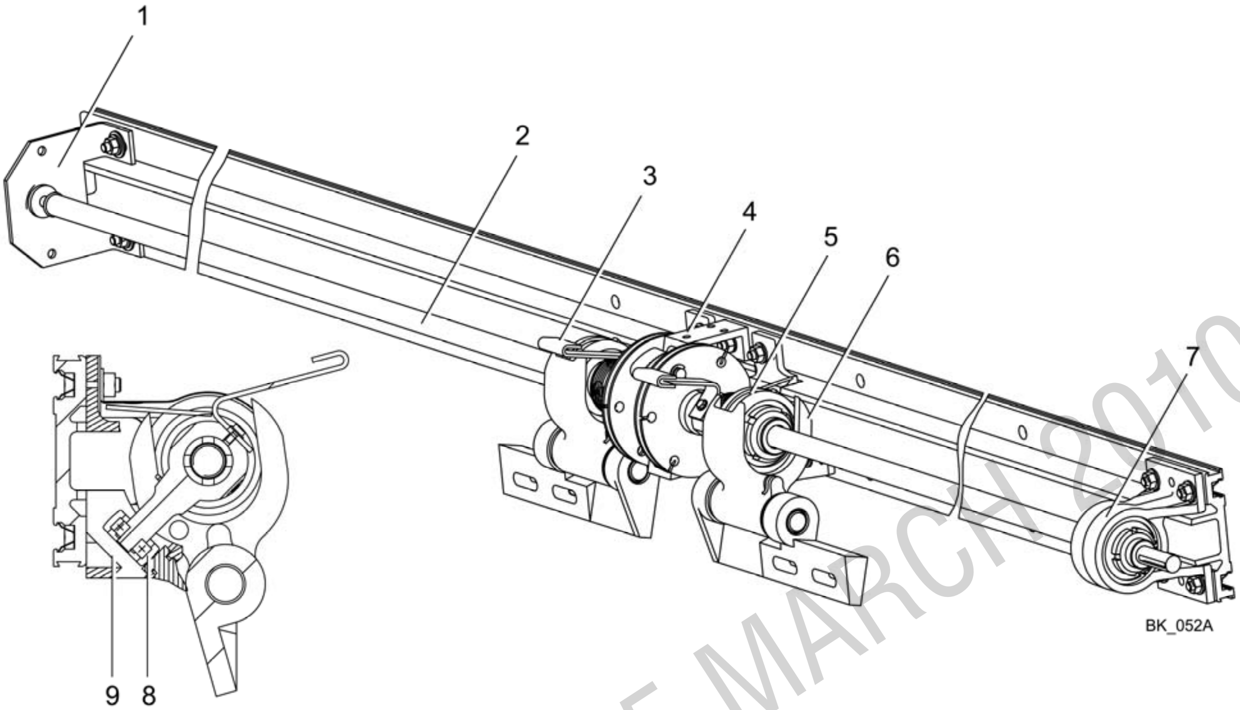
Figure 4.8 Platform End Door



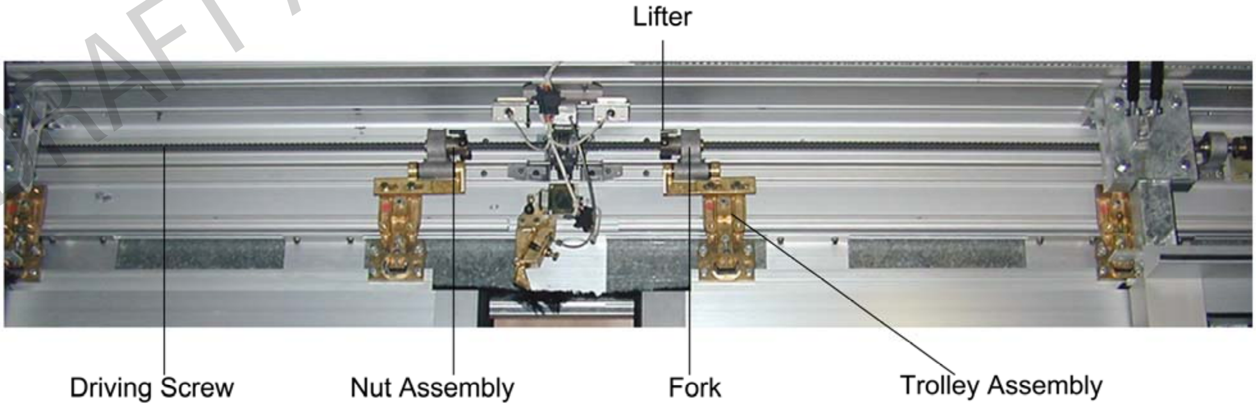
4.7.4 Door Drive Mechanism

Door will be fitted with electro-mechanical drives.

Figure 4.9 Drive Mechanism



1	Equipped extremity bearing	2	Driving screw	3	Lifter
4	Central bearing	5	Driving nut	6	Equipped fork
7	Equipped ball bearing	8	Locking roller	9	Locking slot



4.8 Fire Engineering

The PSD is not a fire resistant barrier or a smoke control barrier. The design aims for the materials used in the platform screen doors are as follows:

- It should be constructed of materials that minimise smoke and heat emission
- In an emergency it should not impair escape from a train; the platform screen and the doors should be capable of being opened manually

4.9 Power Supply

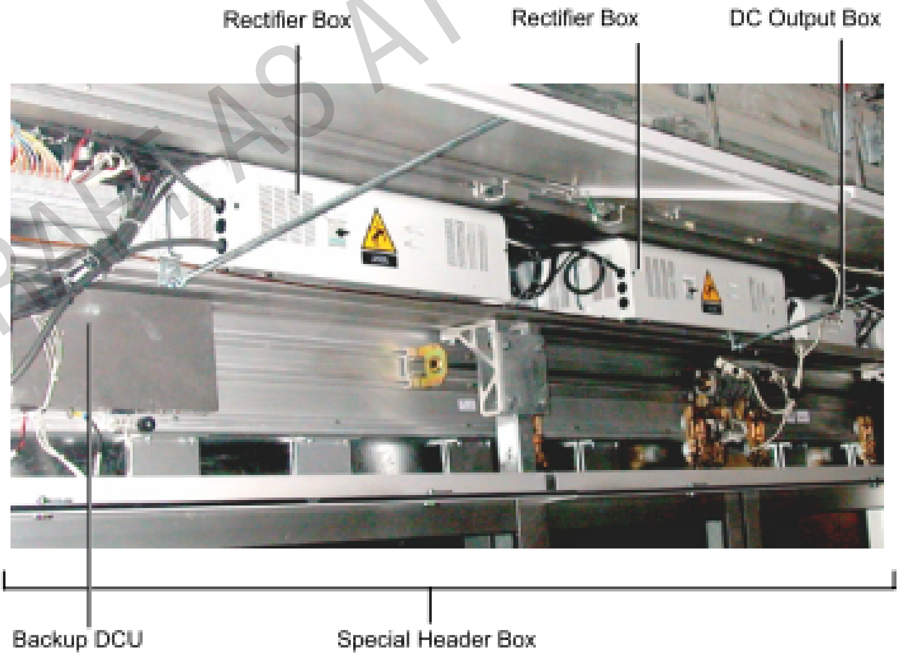
The PSD power will be fed with two types of power, these being:

- dual mains power feeds from the station A and B supplies for powering door mechanisms; and
- dual UPS feeds from the dual station UPS supplies for powering control and monitoring systems.

Both sets of the above power feeds will be fed via isolating transformers to the header box at the centre line of each set of PSDs.

At this location, both the normal mains and UPS supplies will be converted to dc voltages by dual power supplies which will be configured in a 100% redundant manner. The dc voltages will then be fed to dc busbars and distributed to each sliding screen door via circuit breakers.

Figure 4.10 Power Supply



All monitoring and control functions will be powered by the similar centralised DC supply units with an uninterruptible dual battery and chargers. The battery will be sized for 30minutes operation.

Figure 4.10 shows DCU and backup DCU, the later is provided an additional unit to cater for single door failures in order to improve reliability.

4.10 Touch Potential

The PSDs will be bonded to the traction return system in order to minimise touch potential.

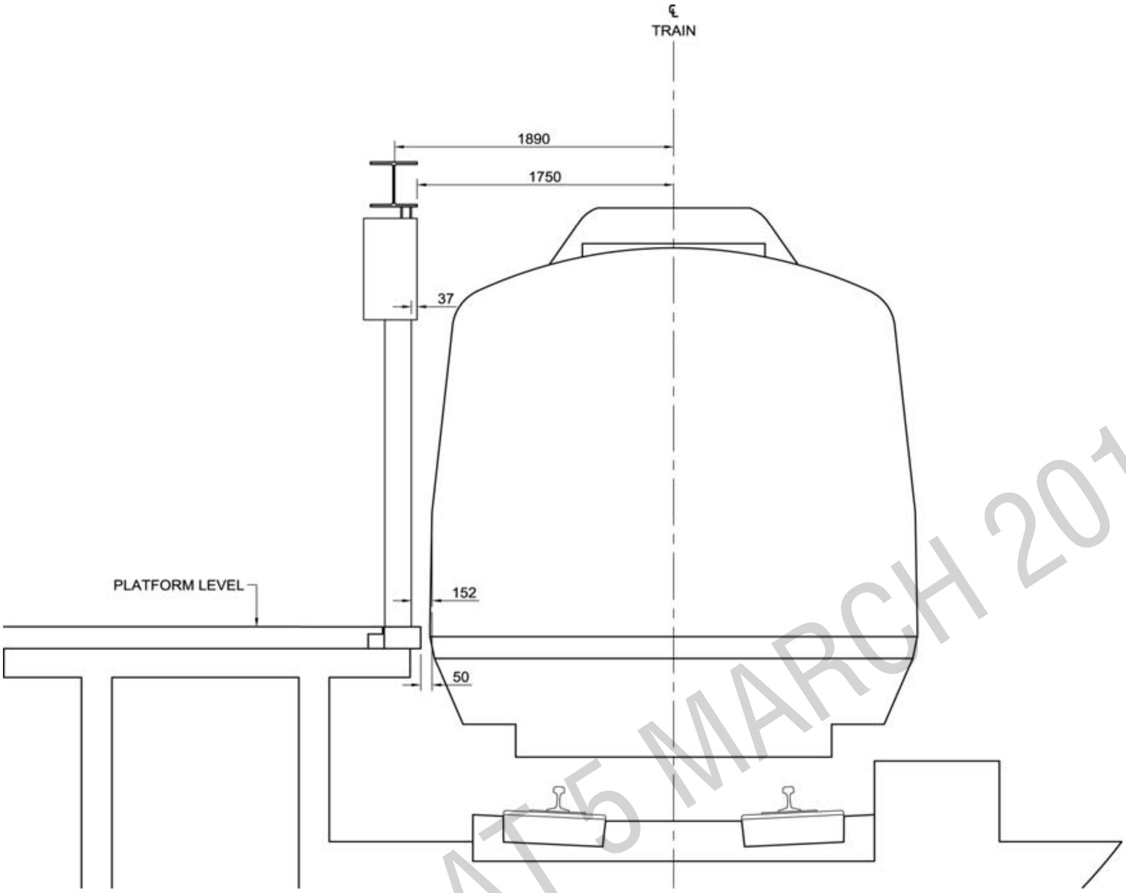
For details of earthing and bonding refer to section 9, Earthing and Bonding report reference WST-2100-PBACH-R-ME-0042 [00] for details

4.11 Stepping Distance

Static stepping distance between train and platform will depend on the kinematic envelope chosen for a non-stopping train. Typically, the stepping distance will be in the region of 50mm.

The PSD design will comply with the safe access for people with disabilities in accordance with the Disability standards on Accessible Public Transport and the intent of the Disability Discrimination Act 1992.

Figure 4.11 Stepping Distances



4.12 Interface with PSTC

The PSD system will provide interface to enable the following conditions to be transferred to the PSTC:

(a) Power supply feeder status;

(b) Fault conditions together with the identification of the specific doors to which they apply;

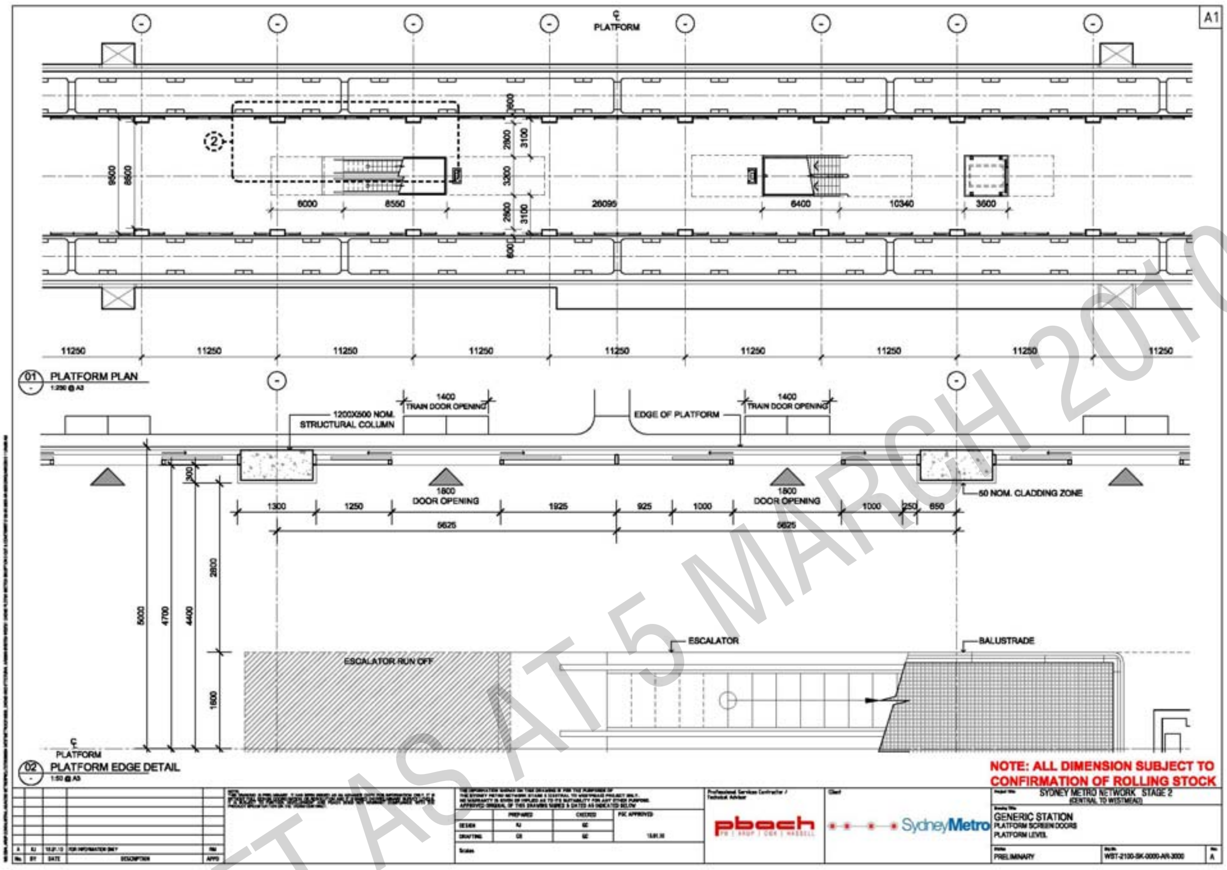
(c) Number of door operations;

(d) Safety loop breaches together with the identification of the specific doors to which they apply; and

(e) Any other parameters necessary to maintain and operate the platform screen doors.

Appendix A Drawings/Sketches

Figure A.1 Generic Station Platform Screen Doors Platform Level



Appendix B Standards

Table B.1

Standard Number	Description	Date
AS/NZS 3000:2007	Electrical Installations (Wiring Rules)	2007
AS/NZS 4292-1:2006	Railway Safety Management – General Requirements	2006
BS7671	IEE Wiring Regulations	
BS 476	Fire Tests on Building Materials and Structures	
BS 6724	Specification for Armoured Cables for Electricity Supply having thermosetting Insulation with low emission of smoke and corrosive gases when affected by fire	
BS 6853	Code of Practice for Fire Precautions in the Design and Construction of Passenger Carrying Trains	
EN50121-4	Railway Applications – Electromagnetic Compatibility – Part 4: Emission and Immunity of the signalling and telecommunications apparatus	
EN12207	Windows and Doors, Air Permeability Classification	
EN50122-1	Earthing and Bonding	
EN50124-1:2001	Railway applications - Insulation coordination -- Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment	2001
EN 50125-3:2003	Railway applications - Environmental conditions for equipment, Part 3: Equipment for signalling and telecommunications	2003
EN50126:1999	Railway Applications –The Specification and Demonstration of Reliability, Availability, Maintainability and Safety	1999
EN50128:2001	Railway Applications – Communications, Signalling and Processing Systems – Software for Railway Control and Protection Systems	2001
EN50129:2003	Railway Applications – Communications, Signalling and Processing Systems – Safety related electronic systems for signalling	2003
EN 50159-1:2001	Railway applications - Communication, signalling and processing systems -- Part 1: Safety-related communication in closed transmission systems	2001
EN 50159-2:2001	Railway applications - Communication, signalling and processing systems -- Part 2: Safety related communication in open transmission systems	2001
IEC60364	Electrical Installations for Buildings	
IEC61508:2002	Functional Safety of Electrical/ Electronic/ Programmable Electronic Safety-Related Systems, Parts 1 to 7	2002
2-01105-001	Platform Edge Doors (LU Standard)	2005
NFPA 220	National Fire Protection Association ‘Standards on Types of Building Construction’	
NFPA 101	National Fire Protection NFPA 101 Association ‘Life Safety Code’	
D/MTRC/NW/DSM/ST/709 /A3 Section 7.9	Platform Screen Doors (HK MTRC Standard)	

Standard Number	Description	Date
BS 7854	'Mechanical Vibration – Evaluation of Machine Vibration by Measurements on non-rotating Parts'	